EFFECTIVENESS OF PROGRESSIVE RESISTANCE TRAINING FOR THE CHILDREN WITH SPASTIC DIPLEGIC CEREBRAL PALSY - A CONTROLLED EXPERIMENTAL STUDY

Dissertation submitted to

The Tamil Nadu Dr. M.G.R. Medical University

Chennai

In partial fulfillment of the requirements for the degree of

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(Advanced Physiotherapy in Pediatrics)

Reg. No. 271540061

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COLLEGE OF PHYSIOTHERAPY

SRI RAMAKRISHNA INSTITUTE OF PARAMEDICAL SCIENCES

COIMBATORE – 641044

CERTIFICATE

This is to certify that the dissertation work entitled "**Effectiveness Of Progressive Resistance Training For The Children With Spastic Diplegic Cerebral Palsy - A Controlled Experimental Study**" was carried out by the candidate bearing the **Register No.271540061 (April 2017)** in College of Physiotherapy, SRIPMS, Coimbatore, affiliated to the Tamil Nadu Dr. M.G.R Medical University, Chennai towards partial fulfillment of the **Master of Physiotherapy (Advanced Physiotherapy in Pediatrics).**

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

Place:

Date:

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I dedicate the study to my Parents **K P Selvaraju, S Parvathidevi** my Brother **Mohan Raju S** and my **Family Members** for providing their love and support in each and every step of my life.

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LIST OF ABBREVIATIONS

❖	CP	:	Cerebral Palsy
❖	PRE	:	Progressive Resistance Exercise
❖	RM	:	Repetition Maximum
❖	GMFM	:	Gross Motor Functional Measure
❖	GMFCS	:	Gross Motor Functional Classification System

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1. INTRODUCTION

Cerebral palsy (CP) is defined as a group of permanent disorders of the development of movement and posture causing activity limitation that are attributed to non-progressive disturbances that occurred in the developing fetal (or) infant brain. The motor disorders of CP are often accompanied by disturbances of sensation, perception, cognition, communication and behaviour by epilepsy and secondary musculoskeletal problems[1]. The **incidence** of CP is well raised above 2.0 per 1,000 live birth in the past 40 years[2].

The Fetal brain injury that occurs during the prenatal, postnatal and neonatal period ends up in CP[3,4]. The **causes** can be specified as: intra uterine exposure to infection, inflammation, disorders of coagulation, interruption of oxygen supply during birth, low APGAR score, seizures, low birth weight, pre term and non specific indicators of neonatal illness[5].

CP can be **classified** based on the movements as hypertonic or spastic, ataxic, dyskinetic, mixed and hypotonic[6]. Based on the function, CP is classified as quadriplegic, diplegic, hemiplegic and monoplegic[7]. Spasticity is the most common movement disorder among the patients with CP [8]. Spastic diplegia is most prevalent form of CP[9].

The term **diplegia** refers to muscle weakness and movement inco-ordination involving the lower limb more than the upper limb[10]. **Clinically** the spastic diplegic CP children at the school age can walk independently, but their walking abilities are worse than their peers without disability[13] and may worsen with age[14] resulting in loss of their walking ability[15]. They have difficulties in doing activities such as getting up and down the stairs and running[10]. Muscle weakness of lower limbs causes the movement dysfunction[11]. The diplegic CP children are grouped under the Gross Motor Function Classification System (GMFCS) levels at I & II[12].

The **management** of the CP children are aimed to improve the functional status. The medical management is by Botulinum toxin injection for the selective spastic muscle[16]. The orthopedic management such as selective dorsal rhizotomy, muscle tendon release and correcting the joint mal-aligment[17] can be used to maintain the muscle balance.

The **physiotherapy management** such as stretching, neuro developmental therapy, strengthening, balance training, gait facilitation, treadmill training, hydrotherapy, electrical stimulation, constraint induced movement therapy, massage, sensory integration,

whole body vibration and vojta[18] are given to improve the functional status of the children. Each treatment technique has a confined effect on the spastic diplegic CP children. Over many years there is no standardized protocol for the management of spastic diplegic CP[8]. Most of the treatments are focused on management of the muscular imbalance of the lower limb[34]. **Strengthening** the weaker muscles can be given to improve the mobility and functional activities spastic diplegic CP children [25].**Progressive resistance exercise** (PRE) is one among the method of strengthening, which increase the capability of muscle to generate more force[19]. So the PRE training can be given to spastic dipegic CP to improve the muscle strength[20].

NEED FOR STUDY

There are various physiotherapy treatments available for the management of spastic diplegic CP to improve the strength in the weaker muscles, gross motor function and independent walking. In spite of the available managements, the improvement in functional status of the spastic diplegic children is not up to the satisfactory level.

There are studies reporting the relationship between the muscle strength, spasticity and motor function which shows the functional status can be improved by strengthening the weaker muscle.[25]

Traditionally clinicians have regards the spasticity as a major factor that contributes to functional limitation and abnormal pattern of movement[39]. Some studies reported that strength training use to be avoided in children with spasticity because it could lead to increase in spasticity and reduce range of motion[11]. On the other hand, the recent studies states that the resistance training would improve the mobility by strengthening without the adverse effects such as increase in tone[26]. This shows that the effect of PRE in spastic diplegic CP management have to be researched further for the clinical evidences.

AIM OF THE STUDY

The study was aimed to find out the effect of PRE training on the functional out come in the spastic diplegic CP children.

OBJECTIVES

1. To find out the effect of PRE training in the spastic diplegic CP on the gross motor function in the experimental group.
2. To find out the effect of conventional therapy in the spastic diplegic CP on the gross motor function in the control group.
3. To find out the effect of PRE training in the spastic diplegic CP on the mobility function in the experimental group.
4. To find out the effect of conventional therapy in the spastic diplegic CP on the mobility function in the control group.
5. To find out the effect of PRE training in the spastic diplegic CP on the strength in the experimental group.
6. To find out the effect of conventional therapy in the spastic diplegic CP on the strength in the control group.
7. To find out the effect of PRE training in the spastic diplegic CP on the spasticity in the experimental group.
8. To find out the effect of conventional therapy in the spastic diplegic CP on the spasticity in the control group.
9. To compare the gross motor functional outcome difference between the experimental and control group.
10. To compare mobility functional outcome difference between the experimental and control group.
11. To compare the strength gain between the experimental and control group.
12. To compare the change in spasticity between the experimental and control group.

HYPOTHESIS

Null Hypothesis

1. There was no significant difference in the gross motor function on the subjects in experimental group.
2. There was no significant difference in the gross motor function on the subjects in control group.
3. There was no significant difference in the mobility on the subjects in experimental group.
4. There was no significant difference in the mobility on the subjects in control group.
5. There was no significant difference in the strength on the subjects in experimental group.
6. There was no significant difference in the strength on the subjects in control group.
7. There was no significant difference in the spasticity on the subjects in experimental group.
8. There was no significant difference in the spasticity on the subjects in control group.
9. There was no significant difference between the experimental and control group in gross motor function.
10. There was no significant difference between the experimental and control group in mobility.
11. There was no significant difference between the experimental and control group in strength.
12. There was no significant difference between the experimental and control group in spasticity.

Alternate Hypothesis

1. There was a significant difference in the gross motor function on the subjects in experimental group.
2. There was a significant difference in the gross motor function on the subjects in control group.
3. There was a significant difference in the mobility on the subjects in experimental group.
4. There was a significant difference in the mobility on the subjects in control group.
5. There was a significant difference in the strength on the subjects in experimental group.
6. There was a significant difference in the strength on the subjects in control group.
7. There was a significant difference in the spasticity on the subjects in experimental group.
8. There was a significant difference in the spasticity on the subjects in control group.
9. There was a significant difference between the experimental and control group in gross motor function.
10. There was a significant difference between the experimental and control group in mobility.
11. There was a significant difference between the experimental and control group in strength.
12. There was a significant difference between the experimental and control group in spasticity.

2. REVIEW OF LITERATURE

Sandy A Ross, *et al.*[25] concluded that the spastic diplegic CP who ambulates with (or) without any assistive device, strength was highly related to function and spasticity does not influence the gait speed.

Jan F Morton, *et al.*[26] reported that there is no adverse effects such as reduced range of motion or increased spasticity accompanied the positive outcomes in strength and function. And encourage the clinicians to consider resistance training along standard therapeutic intervention.

Karen J Dodd, *et al.* [27]stated that strength training can increase strength improve motor activity in people with CP without adverse effects.

Dimitrios patikas, *et al.*[28] confirmed the more significant effect of the strength training may appear if more intense and a specialized training protocol targeted to well motivated patients may have the potential to counteract the obligatory muscle weakening after the operation.

Hua Fang Liao,*et al.* [24] found that after the loaded sit to stand exercise children with mild spastic diplegia improved their basic motor abilities, functional muscle strength and walking efficiency.

Diane L Damiano and Mark F Abel.[30] determined that there was significant strength gain in the muscle targeted. The entire cohort had higher gait velocity as a result of increased cadence with greater capacity to walk faster. GMFM dimension 5 also improved (or) with no change in energy expenditure.

Nicholas F Taylor , *et al.*[19] concluded that progressive resistance exercise appears to be a safe and efficacious intervention for many patients with muscle force deficits contributing to their motor disability in physical therapy.

Karen J Dodd, et al.[31] have reported that strength training programs can improve muscle strength in young people with spastic diplegic CP. Trends also suggest that strength training may have beneficial effects on activities in walking, running and jumping as well as stair climbing.

Olaf Verschuren, *et al.*[32] have provided evidence that these children and adults with CP there is a core set of established clinically feasible exercise. And recommendations may be used to guide health care providers on exercise and daily prescription for level for individual with CP.

Joong Hwi Kim and Hye Jung Seo.[23] have compared the conventional exercise to modified exercise and concluded that there was more effective for trunk hip activation improvement and anterior pelvic tilt motion decreased during standing in children with spastic diplegic CP .

Diane L Damiano, *et al.*[33] stated that children with spastic diplegic CP can increase quadriceps femoris muscle strength through heavy resistance exercise and improved in the degree of crouch at initial floor contact at the freely selected speed and increased fast walking.

Misako ishihara, *et al.*[34] have reported that a trade-off relationship between the hip and ankle joint during gait after plantar flexor training, by which increase the gait speed in CP children.

Anderson , *et al.*[22] reported based on their finding suggested that a 10-week of progressive strength training program improves muscle strength and walking ability without increasing spasticity.

Lee J H *et al.*[35] have concluded from their studies that strengthening exercise could be a useful method to improve gait function of patient with spastic diplegic CP.

O Verschuren *et al.*[36] have proposed on the bases of their systemic review that the improved exercises programs focusing on lower extremity muscle strength and cardiovascular fitness or some combination may be of benefit to children with cerebral palsy.

Vanessa A Scholtes, *et al.*[38] have proved that there was a statistically significant showing effect on muscle strength but not on mobility and spasticity. After 12 weeks of functional PRE strength training increases muscle strength upto 14%. This strength gain did not lead to improved mobility.

Hyung IK Shin, *et al.*[29] stated that there is no correlation between muscle strength and gross motor function. However the study showed that muscle strength, especially of the extensor group of hip and knee joint, might play a critical role in gait by stabilizing pelvic motion and decrease energy consumption in a flexed knee gait.

Aline Scianni *et al.*[37] have stated that the strengthening interventions had no effect on strength, no effect on walking speed and had a small statistically significant, but not clinically worth.

3. METHODOLOGY

Study design

A controlled Experimental study.

Study setting

Physiotherapy Outpatient Department, and Pediatric Inpatient Department of Sri Ramakrishna Multi specialty Hospital, Coimbatore.

Sampling technique

A Convenience sampling.

Sample size

A total of 30 spastic diplegic CP children was selected on the basis of the selection criteria and conveniently allocated in two groups. The group A (experimental group)consist of 15 children and the other group B (control group)consist of 15 children.

Study duration

The study was conducted over a period of 1 year.

Treatment duration

The treatment duration was 12 weeks.

Selection Criteria[21,22,23,24]

a) Inclusion criteria

- Age: 4-10 years
- Both gender
- Able to accept and follow verbal instructions
- Ability to walk independently in indoors and outdoors with (or) without mobility aids
- Children with spastic diplegic CP under the Gross Motor Functional Classification System (GMFCS) level I-III

b) Exclusion criteria

- Unstable seizures
- Any surgical procedures up to 3 months prior to the study
- Botulium toxin injection up to 6 months prior to the study
- Other cardio vascular and pulmonary disease which interferes the resisted training exercise.

Method of collection of data

The selected spastic diplegic CP children were conveniently divided into two equal groups: Group A/ experimental group/ PRE training group and Group B/ control group/ conventional therapy group. The parents (or) the care giver of all the participants were explained about the study and a written consent (Annexure I) was obtained.

All the participants were assessed by the pediatric assessment (Annexure II) which consists of - age, gender, height, weight, developmental history, motor function, gait parameters and physical examination.

The children in the group A received PRE training with conventional therapy and the children in the group B received conventional therapy for period of 12 weeks.

All the participants were evaluated by the GMFCS (Annexure III) for the gross motor functional score before and after completion of the 12 weeks of treatment and the total GMFM score was taken for analysis. The parents (or) care givers of all the participants were given with The Mobility Questionnaire for Children (Annexure IV) and asked to fill it based on the difficulty level in daily activities. The questionnaire was given to the parents (or) the care givers before and after the treatment duration of 12 weeks and the total score was taken for analysis.

All the participants were evaluated by the 6 RM muscle strength test (Annexure V) to know the lower limb muscle strength and modified Ashworth's grade (Annexure VI) to know the spasticity level before and after completion of 12 weeks of the treatment and the outcome score was taken for analysis.

Outcome measures

The assessment tools used were

1. Gross motor function measure score (GMFM) to assess the gross motor function.
2. The mobility questionnaire for children to assess the mobility score.
3. 6 RM muscle strength test to assess the strength of the lower limb muscles.
4. Modified ashworth's grade to assess the spasticity of muscles.

TREATMENT TECHNIQUES

Group A/ experimental group/ PRE training group

The children of this group received the PRE training (Annexure VII) and also the conventional therapy. The PRE training was aimed to improve the strength of Anti–gravity muscles- Hip extensor, Knee extensors and Ankle plantar flexors muscle groups. The children were received training for 6 days (PRE training and conventional training was given in alternative days) in a week for a period of 12 weeks. Each session which last for 40-60 minutes. The PRE training was a circuit training which consisted of 5 stations. They are

1. Initial warm up
2. Leg press
3. Loaded sit to stand
4. Loaded games
5. Unloaded games
6. Relaxation

Group B/ control group/ conventional Group

The children in this group received the conventional physiotherapy (Annexure VIII) in alternative weekdays for a period of 12 weeks, Each session which lasts for 40-60 minutes.

The training includes

1. Stretching
2. Whole body relaxation
3. Neuro developmental therapy
4. Swiss ball exercises
5. Weight bearing exercise
6. Balance training
7. Gait training
8. Static cycling
9. Functional oriented playing activities.

MATERIALS

- Exercise mat
- Leg press station
- Swiss ball
- Weight jackets
- Weight cuff for additional weights
- Wobble board
- Chair without back support and arm rest
- Stepper
- Consent form
- Questionnaire
- Recording sheets
- Stationeries

4. DATA ANALYSIS AND RESULTS

Data collected from participants of the same group were analyzed by using paired '*t*' test and the differences between the two groups were analysed using independent '*t*' test.

Paired 't' Test:

$$t = \frac{\bar{d}\sqrt{n}}{SD}$$

$$SD = \sqrt{\frac{\sum(d-\bar{d})^2}{n-1}}$$

$\bar{d}$ = calculated mean difference between pre-test and post-test values

d = difference between pre-test and post-test values

n = sample size

SD = Standard Deviation.

Independent 't' test:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{SD\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$$SD = \sqrt{\frac{(n_1 - 1)SD_1^2 + (n_2 - 1)SD_2^2}{(n_1 + n_2) - 2}}$$

Where,

$\overline{X_1}$ = Mean of Group A

$\overline{X_2}$ = Mean of Group B

n_1 = number of subjects in Group A

n_2 = number of subjects in Group B

SD_1 = Standard deviation of Group A

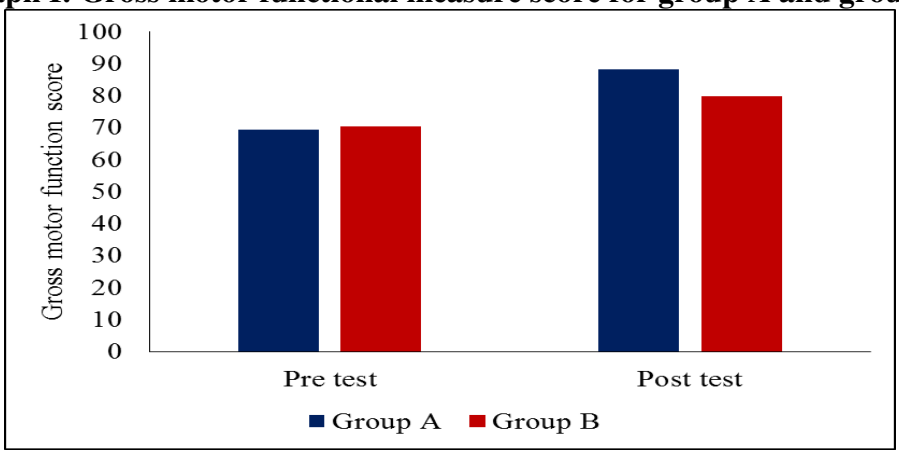
SD_2 = Standard deviation of Group B

DATA INTERPRETATION:

Table I: Gross motor functional measure score for group A and group B

Groups		N	Mean	Mean Difference	S.D	The calculated 't' value
GROUP A	PRE	15	69.2	19	4.02	8.6641
	POST	15	88.2			
GROUP B	PRE	15	70.4	9.3	2.20	16.07
	POST	15	79.69			

Graph I: Gross motor functional measure score for group A and group B



RESULTS:

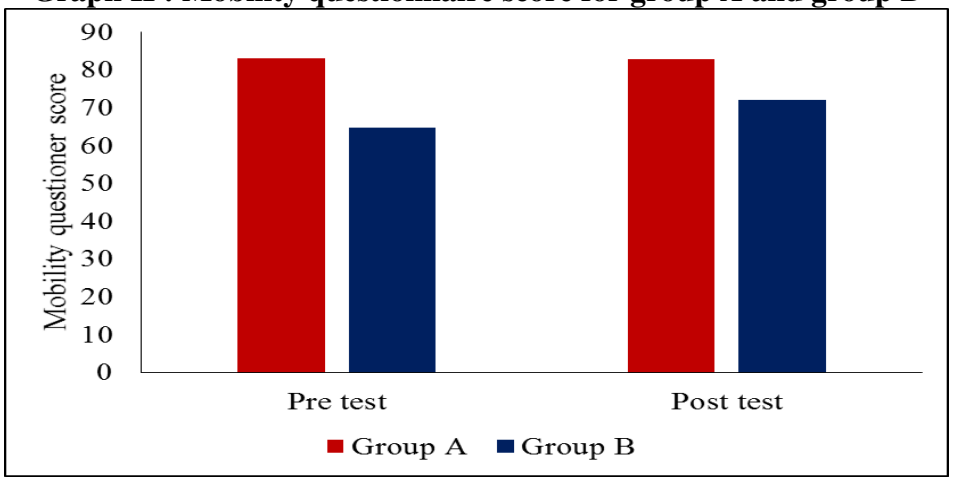
GROUP A: The mean and the standard deviation of the group A is 19 and 4.02. The calculated 't' value is 8.6641 which is greater than the table value (1.76) at level of $p<0.05$. The result showed that there is a significant difference between the pre and post test of GMFM score among the participants of group A.

GROUP B: The mean and the standard deviation of the group B is 9.13 and 2.20. The calculated value 't' is 16.07 which is greater than the table value (1.76) at level of $p<0.05$. The result showed that there is a significant difference between the pre and post test of GMFM score among the participants of group B.

Table II : Mobility questionnaire score for Group A and group B

Groups		N	Mean	Mean Difference	S.D	The calculated 't' value
GROUP A	PRE	15	82.93	18.87	4.46	16.3737
	POST	15	64.67			
GROUP B	PRE	15	82.73	10.867	3.11	13.52
	POST	15	72			

Graph II : Mobility questionnaire score for group A and group B



RESULTS:

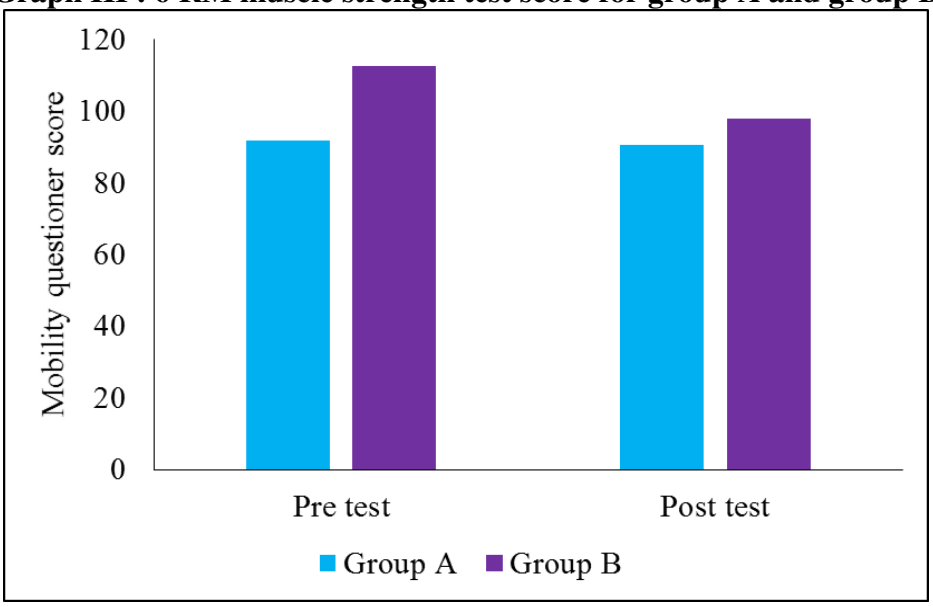
GROUP A: The mean and the standard deviation of the group A is 18.87 and 4.46. The calculated 't' value is 16.3737 which is greater than the table value (1.76) at level of $p<0.05$. The result showed that there is a significant difference between the pre and post test of Mobility questionnaire score among the participants of group A.

GROUP B: The mean and the standard deviation of the group B is 10.867 and 3.11. The calculated value 't' is 13.52 which is greater than the table value (1.76) at level of $p<0.05$. The result showed that there is a significant difference between the pre and post test Mobility questionnaire score among the participants of group B.

Table III: 6 RM muscle strength test score for group A and group B

Groups		N	Mean	Mean difference	S.D	The calculated 't' value
GROUP A	PRE	15	91.6	21.4	3.63	22.18
	POST	15	112.67			
GROUP B	PRE	15	90.46	6.87	4.93	5.37
	POST	15	98			

Graph III : 6 RM muscle strength test score for group A and group B



RESULTS:

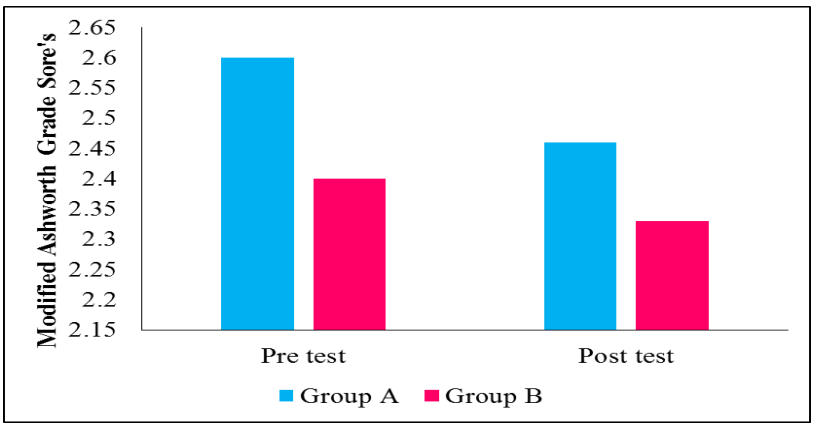
GROUP A: The mean and the standard deviation of the group A is 21.4 and 3.63. The calculated 't' value is 22.18 which is greater than the table value (1.76) at level of $p<0.05$. The result showed that there is a significant difference between the pre and post test of 6 RM muscle strength test score among the participants of group A.

GROUP B: The mean and the standard deviation of the group B is 6.87 and 4.93. The calculated 't' value is 5.37 which is greater than the table value (1.76) at level of $p<0.05$. The result showed that there is a significant difference between the pre and post test of 6 RM muscle strength test score among the participants of group B.

Table IV : Modified Ashworth grade for group A and group B

Groups		N	Mean	Mean difference	S.D	The calculated 't' value
GROUP A	PRE	15	2.6	0.133	0.35639	1.4485
	POST	15	2.46			
GROUP B	PRE	15	2.4	0.06	0.2589	0.8976
	POST	15	2.33			

Graph IV : Modified Ashworth grade for group A and group B



RESULTS :

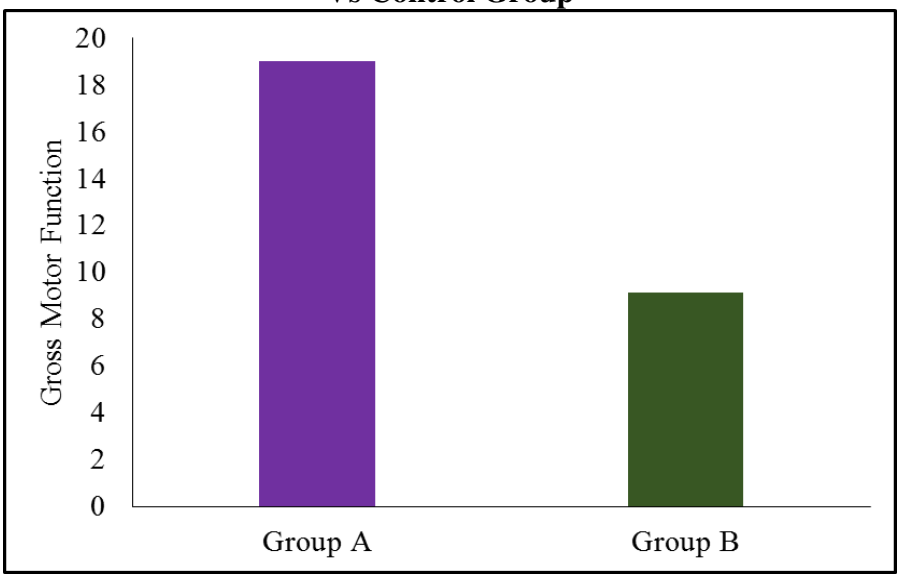
GROUP A: The mean and the standard deviation of the group A is 0.133 and 0.35639. The calculated 't' value is 1.4485 which is less than the table value (1.76) at level of $p<0.05$. The result showed that there is no significant difference between the pre and post test of modified ashworth score among the participants of group A .

GROUP B: The mean and the standard deviation of the group B is 0.06 and 0.25892 The calculated 't'value is 0.8976 which is lesser than the table value (1.76) at level of $p<0.05$. The result showed that there is no significant difference between the pre and post test of modified ashworth score among the participants of group B .

Table V: Gross Motor Functional Measure Score in Experimental Group Vs Control Group

Parameters	Group	Mean	S D	calculated 't' value	table 't' valve
Gross Motor Function	GROUP A	19	3.35	7.96	1.76
	GROUP B	9.13			

Graph V: Gross Motor Functional Measure Score in Experimental Group Vs Control Group



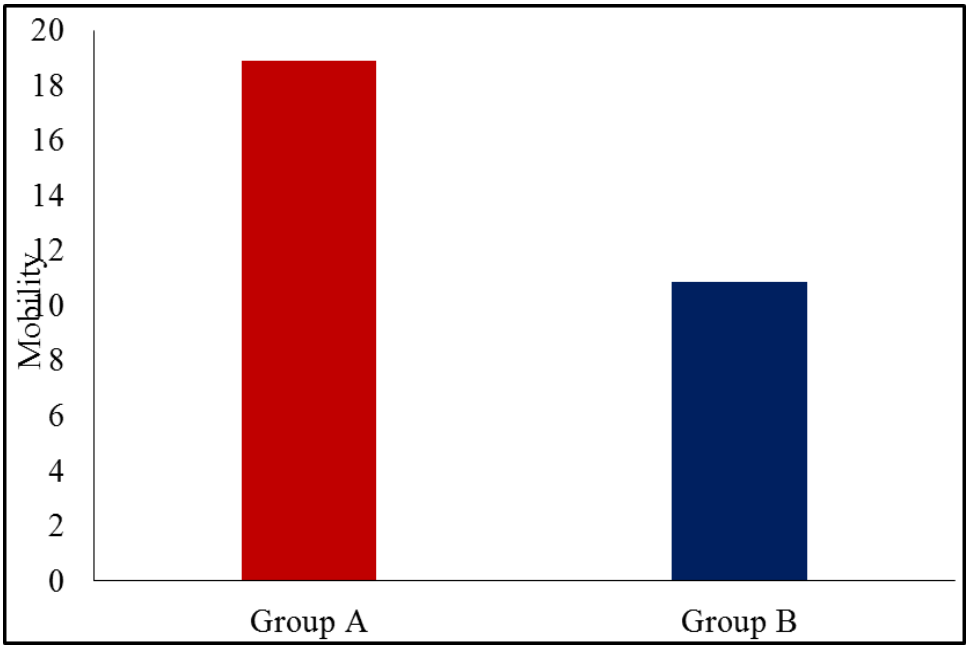
RESULTS:

The mean value of the experimental group(19) is greater than the mean value of control group(9.13). The calculated 't' value is 7.96 which is greater than the table value(1.76). the study showed that there is significant difference gross motor function of PRE training and control group of spastic diplegic CP at the level of $p<0.05$. This shows that PRE training is effective than the conventional therapy in improvement of gross motor function.

Table VI: Mobility Questionnaire Score In Experimental Group Vs Control Group

Parameters	Group	mean	S D	calculated 't' value	Table 't' valve
Mobility	GROUP A	18.87	3.84	5.6327	1.76
	GROUP B	10.867			

Graph VI : Mobility Questionnaire Score In Experimental Group Vs Control Group



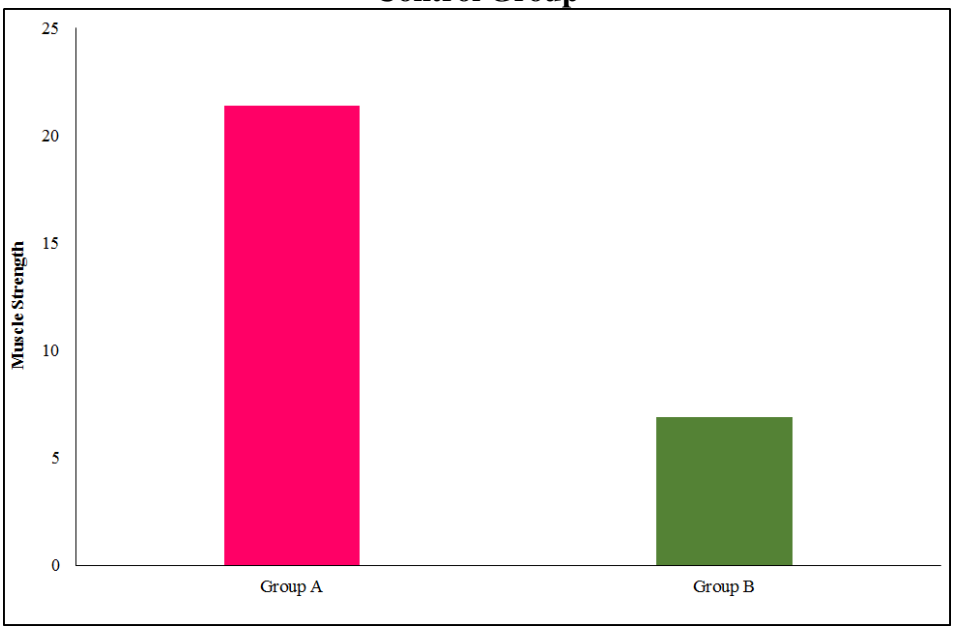
RESULTS:

The mean value of the experimental group(18.87) is greater than the mean value of control group(10.867). The calculated 't' value is 5.6327 which is greater than the table value(1.76). The study shows that there is significant difference in the effect on mobility of PRE training and control group of spastic diplegic CP at the level of $p<0.05$. This shows that PRE training is effective than the conventional therapy in the improvement of the mobility function.

Table VII : 6 RM Muscle Strength Test Score In Experimental Group Vs Control Group

Parameters	Group	Mean	S D	calculated 't' value	table 't' valve
Muscle Strength	GROUP A	21.4	4.33	9.0693	1.76
	GROUP B	6.87			

Graph VII : 6 RM Muscle Strength Test Score In Experimental Group Vs Control Group



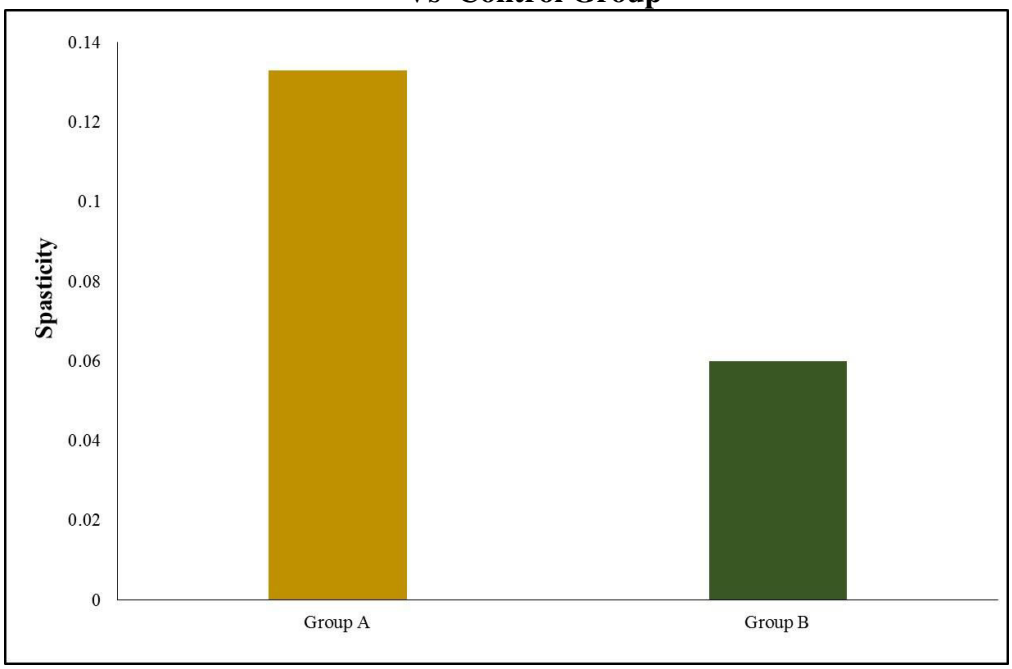
RESULTS:

The mean value of the experimental group (21.4) is greater than the mean value of control group(6.87). The calculated 't' value is 9.0693 which is greater than the table value(1.76). The results show that there is significant difference in the effect on muscle strengthening of PRE training and control group of spastic diplegic CP at the level of $p<0.05$. This shows that PRE training is effective than the conventional therapy in improve the strength in the lower limb muscles.

Table VIII : Modified Ashworth Scale Test Score In Experimental Group Vs Contol Group

Parameters	Group	Mean	S D	calculated 't' value	Table 't' valve
Spasticity	GROUP A	0.133	0.3114	0.6334	1.76
	GROUP B	0.06			

Graph VIII : Modified Ashworth Scale Test Score In Experimental Group Vs Control Group



RESULTS :

The mean value of the experimental group(0.133) is lesser than the mean value of control group(0.06). The calculated 't' value is 0.6334 which is lesser than the table value(1.76). The result shows that there is no significant difference in the effect on muscle tone of PRE training and control group of spastic diplegic CP at the level of $p<0.05$. This shows that PRE training and the conventional therapy have no effect on muscle tone in the spastic CP children.

Table IX : Demographic data results

Characteristic Features		Group A	Group B
GMFM Level	I	4	6
	II	8	7
	III	3	2
Age	4-7	12	12
	8-10	3	3
Gender	Boys	10	9
	Girls	5	6

A total number of 30 children were selected the study. Based on the severity level, 10 children were under GMFM level I, 15 children were under GMFM level II, and the remaining 5 children in GMFM level III. Based on the age parameter 24 children were in the age group of 4-7 and 6 children in the age group of 8-10. Based on the gender 19 children were boys and the remaining 11 children were girls.

5. DISCUSSION

The study was aimed to investigate the effects of PRE on the spastic diplegic CP children. The children with spastic diplegic CP have the problem of muscle imbalance in the lower limb which limits their functional activity. These children can walk independently with (or) without assistance, but with poor mobility and gross motor function, compared with other children without disabilities. There are previous studies stated the relationship between the gross motor function and strength. So strengthening the weaker muscle can be improve the gross motor function.

For the study purpose 30 spastic diplegic CP children were selected on the basis of selection criteria and divided into two equal groups. Whereas Group A was an Experimental group and Group B was a control group. Based on the level of severity, 10 children were comes under the GMFM level I, 15 children were comes under the GMFM level II, and the remaining 5 children were comes under the GMFM level III. Based on the age parameter 24 children were in the age group of 4-7 and 6 children were in the age group of 8-10. Based on the gender 19 of them were boy and remaining 11 were girls.

At the baseline of the study all the participant were evaluated by the GMFCS for the gross motor functional measure evaluation, 6 RM muscle strength test for the muscle strength evaluation, Modified Ashworth's scale for spasticity grading evaluation and The Mobility questionnaire which is filled by the care giver of the children to evaluate the mobility functional score. The collected data were taken as the pre interventional scores for analysis. Group A (experimental group) was given PRE training and the conventional therapy. Group B(control group) was given only the conventional therapy. The treatment duration was over a period of 12 weeks. After the treatment duration all the participants were re-evaluated by the same assessment tools and the collected data were taken as post interventional scores for analysis.

The collected data was statistically analyzed in order to compare the variables with in the group was done by paired 't' test and to compare the variables between the two group was done by independent 't' test. The difference were considered at the significant level of '$p' < 0.05$.

The statistical analysis of the variables with in the group result showed significant difference. **GMFM** result showed in the Table I and Graph I accepted the alternative hypothesis 1 and 2 and confirmed the effect of treatment on the Gross motor function in both the groups. **The Mobility Questionnaire** result showed in the Table II and Graph II accepted the alternative hypothesis 3 and 4 and confirmed the effect of treatment on the Mobility function in both the groups. **6 RM Muscle strength test** result showed in the Table III and Graph III accepted the alternative hypothesis 5 and 6 and confirmed the effect of treatment on the Muscle strength in both the groups. And **The Modified Ashworth's spasticity grade** result showed in the Table IV and Graph IV accepted the Null hypothesis 7 and 8 and confirmed that there was no effect of treatment on the Spasticity grade in both the groups.

The statistical analysis of the variables between the experimental and control group result showed significant difference. **GMFM** result showed in the Table V and Graph V accepted the alternative hypothesis 9 and confirmed that the PRE training was effective than the conventional therapy on the Gross motor function. **The Mobility Questionnaire** result showed in the Table VI and

Graph VI accepted the alternative hypothesis 10 and confirmed that the PRE training was effective than the conventional therapy on the on the Mobility function. **6 RM Muscle strength test** result showed in the Table VII and Graph VII accepted the alternative hypothesis 11 and confirmed that the PRE training was effective than the conventional therapy on the Muscle strength. And **The Modified Ashworth's spasticity grade** result showed in the Table VIII and Graph VIII accepted the Null hypothesis 12 and confirmed that there was no effect of both the PRE and conventional therapy on the Spasticity.

The results confirmed the effect of PRE training was effective than the conventional therapy in the improvement of the gross motor function, mobility function and strength without the adverse effects of increasing spasticity. The result supported the previous studies which stated the PRE can improve the functional status without the adverse effect [26,27]. Result of the study showed the relationship with the muscle strength and gross motor function[25]. The study determined that there was significant strength gain in the muscle targeted in the lower limbs, which was also stated in the other studies showed the direct relationship between the lower limb muscle strength and gait

parameters[30]. The gained strength of the lower limb muscles can improve the function by strengthened hip muscle stabilizing the pelvic motions in walking[24,23], the strengthened knee muscle can improved the degree of crouch gait and increased fast walking[26], the strengthened ankle muscle can improve the propulsive action of the foot in terminal stands phase[34], decreased energy consumption by normalizing the abnormal joint posistion[29], and cardiovascular fitness gained after the PRE training[36]. All these factors contributed for the improvement in the gait parameters such as increased speed, increased stride length, increased cadence and increased single limb balancing during walking .

The expected possible adverse effect was increase in the spasticity but have no effect found on it. The functional status is improved whereas the spasticity remains same. This showed the relationship between the spasticity and gross motor function and mobility. It confirmed that the gross motor function, walking ability was not influenced by the spasticity.

RECOMMENDATIONS

- Participants with a large sample can be studied.
- The effect on various age group can be studied.
- Spastics diplegic severity specific effects can be studied.
- Studies with other types of spastic CP varying in the functional status can be conducted
- Long term effect of PRE can be studied .
- The Tamil translated version of the Mobility Questionnaire for children can be used to yield a better outcome as the original Questionnaire is available in the English version. The questionnaires were explained to the subjects in their local language and the filled forms were obtained.

6. CONCLUSION

The study confirmed the effect of PRE training in the functional status of the spastic diplegic CP who are ambulating. The result of the study showed that the PRE for spastic dipelgic CP can increase the strength of the muscle thus improve gross motor function and mobility without the adverse effect of increased muscle tone.

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ANNEXURE-I

CONSENT FORM

I, ----------**(parent/caregiver)** hereby agree to provide my fullest consent and co- operation to allow my child to be taken as a subject for the research work of ---------- entitled ***"Effectiveness of progressive resistance training of the children with spastic diplegic cerebral palsy –A controlled experimental study".*** I have decided to volunteer my child for study on my own will and was not compelled by any individual or group of people and my consent is not for any monetary benefits.

The possible outcome and effects of the study as well as the procedure that will be executed on my child is fully explained to me by an investigator in the language best known to me and I am aware that my child being subjected to this study and I'll have to give more time for assessments and treatments.

The questions and queries I have posed have been answered to my satisfaction and I am aware that my child identity will be kept confidential. I am also aware that I can discontinue the study on my child at anytime without adversely affecting my child treatment.

The matter in this consent form was read by me / read to me by an investigator and I fully understood the subject matter.

Sign. of the Parent/Caregiver **Sign. of the investigator**

Place & Date:

ANNEXURE-II

ASSESSMENT FORM

Name: GROUP: ID NO:

Age: Date of assessment:

Gender:

Height:

Weight:

Informant:

Developmental history

Current abilities:

Current disabilities:

Deformity/Weakness:

Trunk control:

Achieved goals up to age:

GMFM level: GMFM score:

Higher mental functions:

Cognitive development

Social adaptive:

Speech:

Vision:

Hearing:

Gait parameters:

Mobility aids:

Splints:

Symmetry in walking:

Duration of walking with assistance:

Duration of walking without assistance:

Falling history during walking:

Playing activates with the peer group:

Running:

Jumping:

Stair climbing:

ANNEXURE-III

GROSS MOTOR FUNCTION MEASURE (GMFM)

Score sheet

Name: GROUP: ID NO:

GMFM Level: DATE OF ASSESSMENT:

Testing condition (room, clothing, time, other present specification):

DIMENSION : STANDING

Item No	Dimension : standing	Score
1	On the Floor: Pull to Stand at large bench	
2	Stand: maintains, arms free,3 sec	
3	Stand: holding on to large bench with one hand, lifts Right foot,3sec	
4	Stand: holding on to large bench with one hand, lifts Left foot,3sec	
5	Stand: maintains, arms free,20sec	
6	Stand: lifts R foot, arms free, 10sec	
7	Stand: lifts L foot, arms free, 10sec	
8	Sit on small bench: Attains to stand without using arms	
9	High kneeling: Attains to stand through half kneeling on Right knee, without using arms	
10	High kneeling: Attains to stand through half kneeling on Left knee, without using arms	
11	Stand: Lowers to sit on floor with control , arms free	
12	Stand: attains squat, arms free	
13	Stand: Pick up objects from floor,arms free, returns to stand	

Total score:

DIMENSION : Walking, Running And Jumping

Item No	Dimension :walking, running and jumping	Score
1	Stand: 2 hands on large bench: cruises 5 steps to Right	
2	Stand: 2 hands on large bench: cruises 5 steps to Left	
3	Stand:2 hand held: walk forwards 10 steps	
4	Stand:1 hand held: walk forwards 10 steps	
5	Stand: walks forwards 10 steps	
6	Stand: walks forwards 10 steps, stops, turns 180^0, returns	
7	Stand: walk backwards 10 steps	
8	Stand: walks forwards 10 steps carrying a large object with 2 hands	
9	Stand: walks forwards 10 consecutive steps between parallel line	
10	Stand: walks forwards 10 consecutive steps on a straight line	
11	Stand: steps over stick at knee level Right foot leading	
12	Stand: steps over stick at knee level Left foot leading	
13	Stand: runs 4.5m stops and return	
14	Stand: kick ball with Right foot	
15	Stand: kick ball with Left foot	
16	Stand: jumps 30 cm high, both the feet simultaneously	
17	Stand: jumps forwards 30 cm, both the feet simultaneously	
18	Stand on R Foot : hops on R foot 10 times within a circle	
19	Stand on L Foot : hops on L foot 10 times within a circle	
20	Stand Holding 1 rail: walks up 4 steps, holding 1 rail alternating feet	
20	Stand Holding 1 rail: walks down 4 steps, holding 1 rail alternating feet	
21	Stand: walks up 4 steps alternating feet	
22	Stand: walking down 4 steps alternating feet	
23	Stand on 15 cm step: jumps off, both feet simultaneously	

Total score:

INTERPRETATION

The GMFM is a standardized observational instrument designed and validated to measure change in gross motor function over time in children with cerebral palsy. The grading system consist of 5 dimensions – Lying &rolling, sitting, crawling& kneeling, standing and walking. The scoring is done by the investigator based on the performed item by the child.

Scoring key

0 = does not initiate

1 = initiates

2 = partially completes

3 = completes.

The investigator evaluate the child and awarded scores for the each items and the sum of all dimension is taken as the total score. This score predicts the functional status and the used to set the goal for future management.

The study was to find the effect of training in the functional and mobility improvement. So the mobility component of the GMFM - standing and walking dimension was taken for the outcome analysis.

ANNEXURE-IV

MOBILITY QUESTIONNAIRE FOR CHILDREN

Name: GROUP: ID NO:

The informant:
Date:

Please tick (✓) in the following columns based on your child's difficulty in each activity.

INTERPRETATION:

This is a standard questionnaire to evaluate the mobility of the child which was filled by primary care giver. They were asked to fill the questioner based on their child's difficulty level.

For the analytic purpose, the investigator converts the subjective data (which was given by the care giver) into the numerical data by grading the level of difficult as follows.

0= not difficulty at all

1= sight difficulty

2= somewhat difficulty

3= very difficult

4=impossible without help

The sum of all the score was taken as the total score. High the score, high the level of difficulty and low the level of score low the level of difficulty.

The care givers of all the participant were given with this mobility questionnaire and asked fill as instructed, before the treatment and after the treatment then the collected data was analyzed.

INDOOR ACTIVITIES

Sl.No	How difficult was it for your child to……..	Not difficult at all	Slight difficult	Some what difficult	Very difficult	Impossible with out help
1	Sit down on a bed					
2	Turn over in bed					
3	Get out of bed					
4	Walking indoors at home					
5	Stand still at home					
6	Sit down on a chair					
7	Sit on a chair					
8	Get up from chair					
9	Walk to and from the toilet					
10	Sit down on the toilet					
11	Get up from the toilet					
12	Walk barefoot					
13	Stand still barefoot					
14	Bend down to the floor					
15	Sit down on the floor					
16	Get up off the floor					
17	Sit on stool					
18	Get into the shower					
19	Stand while taking a shower					
20	Get out of the shower					
21	Walk up stairs					
22	Walk up stairs with something in hands					
23	Walking down stairs					
24	Walk down stairs with something in hands					
					Total	

OUTDOOR ACTIVITIES

Sl. No.	How difficult was it for your child to……..	Not difficult at all	Slight difficult	Some what difficult	Very difficult	Impossible with out help
25	Walking out doors					
26	Stand still out doors					
27	Walk to and from the car					
28	Get into car					
29	Get out of car					
30	Walk on flat surface					
31	Walk on an uneven surface					
32	Walk for a quarter of an hour outdoor					
33	Walk for half an hour outdoor					
34	Walk for an hour outdoor					
35	Walk on asphalt					
36	Walk on grass					
37	Walk on sand					
38	Walk over ”obstacles” such as curbs					
39	Get on a bicycle					
40	Ride a bicycle					
41	Get off a bicycle					
42	Play outdoors					
43	Kick a ball					
44	Run					
45	Run on asphalt					
46	Run on grass					
47	Run on sand					

Total Score

ANNEXURE-V

6 RM MUSCLE STRENGTH TEST

The strength of the muscles of the lower limb is calculated according to the individual by 6RM Test. In general practice the 1 RM test is used. 1 RM is defined as the maximum amount of weight that can be lifted in one single repetition. The 1 RM is considered to be too heavy for the children. The study used 6 RM instead of 1RM. The 6RM was predicted on basis of the individual child's GMFM level and body weight [21].

The predicted 6 RM is approximately equal to 86% of the body weight were as 1 RM is equal to 100% of body weight [41,42]. The 6 RM was calculated by trial and error method in the predicted load. The child was instructed to perform the third trail at 100% of predicted 6RM until temporary muscle exhaustion or until a maximum of 6 repetition(range 5-7) based on the early studies. The leg press load for the 6RM was estimated for the individual as shown in the table.

GMFM LEVEL	Estimated percentage of body weight
I	130%
II	110%
III	90%

Steps to evaluate the 6 RM for the individual child:

- The 6 RM test procedures were initiated after the children had familiar with the training program and when after they could perform the exercise correctly.
- Initially the child stated with 3 repetition(no load) to practice the correct performance through full possible range of motion, with adequate speed through
- Then two warm up trail of 3 repetition were performed at 50% and 70% of the predicted 6 RM.
- After the trail period and actual test trail, the child was instructed to perform the 100% of predicted 6RM until muscle exhaustion or until a maximum of 10repetition.
- If the child performed correctly then 5-10% is added.
- After a 3 minute of rest the trail was performed until the child able to perform 5-7 repetition but not more than that. Thus the child's 6RM was found.

ANNEXURE-VI

MODIFIED ASHWORTH SCALE

0	Normal tone
1	Slight increase in muscle tone manifested by a catch and release by minimal resistance at the end of ROM when the affected part is moved
1+	Slight increase in tone, catch followed by a minimal resistance through out the remaining ROM
2	Most marked increase in tone through out most of the ROM but affected part still easily movable
3	Considerable increase in tone, passive movement difficult
4	Affected part rigid in flexion or extension

INTERPRETATION:

During the physical examination all the participants were evaluated for the spasticity by Modified Ashworth's scale. The lower limb muscles of the individual child was assessed by the scale and based on the muscle response the spasticity was graded.

ANNEXURE-VII

TREATMENT FOR THE PROGRESSIVE RESISTANCE TRAINING GROUP

Progressive resistance exercise (PRE) is a method of increasing the ability of muscle to generate force[19]. There are some principles given by the American college of sports medicine. They are

1 To perform a small number of repetition until fatigue.

2 To allow adequate period of rest between exercise for recovery.

3 To increase the resistance as the ability to generate force increase.

The treatment protocol have been designed considering these recommendation.

Usually 1 RM is used for training. But it is to heavy for the children population. So the training was by the 8RM load. The 8 RM load was predicted for the single child based on the individual Gross Motor Functional Level and the body weight.

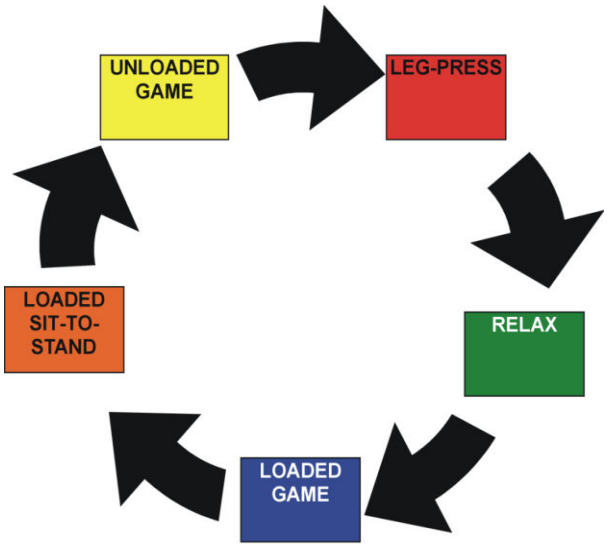
Station	GMFCS level	Predicted 8RM
Leg press	I	120% of the body weight
Leg press	II	100%of the body weight
Leg press	III	80% of the body weight

Steps to evaluate the 8 RM for the individual child:

- The 8 RM test procedures were initiated after the children had familiar with the training program and when after they could perform the exercise correctly.
- Initially the child stated with 3 repetition(no load) to practice the correct performance through full possible range of motion, with adequate speed through
- Then two warm up trail of 3 repetition were performed at 50% and 70% of the predicted 8 RM.
- After the trail period and actual test trail, the child was instructed to perform the 100% of predicted 8RM until muscle exhaustion or until a maximum of 10 repetition.
- If the child performed correctly then 5-10% is added.
- After a 3 minute of rest the trail was performed until the child able to perform 7-9 repetition but not more than that. Thus the child's 8RM is finalized.
- The 8RM was used as the resistance in the PRE training
- Which was progressed gradually based on the individual performances.

The loading recommendation was 8-12 RM. Should be lifted 1 to 3 sec. Training was given in 3 alternative days per week.

The muscle have been targeted are Anti –gravity muscle- Ankle plantar flexors, Knee extensors and Hip extensor muscle groups. The training circuit was as follows.



Characteristics of the training

S.N	Station	Load	Trained leg	Exercise	Functional	Resistance
1	Leg-press	High	Bilateral	Leg-press	No	Leg press
2	Loaded sit- to-stand	High	Bilateral	Sit-to-stand	Yes	Weight vest
3	Loaded game	Low	Unilateral	Half knee rise; lateral set up; forward step- up;	Yes	Weight vest
4	Unloaded game	No	Unilateral	Half knee rise; lateral set up; forward step- up;	Yes	Body weight
5	Relax	n.a.	n.a.	n.a.	n.a.	n.a.

Training volumes of progressive resistance exercise:

SN	Station	Training volume maximum load	Repetitions	Sets	Rest
1	Leg- press	100% 8 RM	8	3	90 sec
2	loaded sit- to-stand	75% 8 RM	8	3	90 sec
3	Loaded game	25% 8 RM	8	3	90 sec
4	Unloaded game	body weight	8	3	90 sec
5	Relax	n.a.	n.a.	n.a.	n.a.

*n.a. Not applicable

LEG PRESS:

Initial Starting position	**:**	Sitting with flexed hip and knees. Hands holding the handgrips. Hips and knees :flexion. Feet evenly placed on the footpad.
Instructions	**:**	Slowly push the footpad forward, keep knees slightly flexed and bend back again slowly.
Trainer	**:**	The trainer stands or sits beside the child.

Loaded Sit- to- Stand:

Initial Starting position	**:**	Sitting on chair. The chair without back and arm rest.
Instructions	**:**	Stand up slowly, stand still, then sit down again slowly ,do not use hands as much as possible.
Trainer	**:**	The trainer stands beside or front of the child.

Loaded Games:

The loaded games are trained in functional oriented task like half knee rise, lateral step up, forward step up, and various other exercises with the added weights in the waist band.

Unloaded Games:


The unloaded games are also based on the functional activates. The exercise with the resistance of only body weight. They are half knee rise, sit-to-stand, forward step up, lateral step up.

Relaxation:

With in the circuit time is allowed for relaxation. The relaxation techniques such as deep breathing, slow walking, slow static cycling. This is to balance the circulation in the worked out muscle.

This circuit training is continued for the treatment duration of 40-60 minutes. Every training session ends in relaxation phase.

ANNEXURE-VIII

TREATMENT PROTOCOL FOR THE CONVENTIONAL THERAPY GROUP

Stretching:

Stretching was given to lengthening and improve the exercise performances. The plantar flexors, hamstrings and other spastic muscles stretched. The child was positioned comfortably, then the individual muscle is put in to sustained lengthened position for 30 sec and released. Every stretching is repeated for 3-5 times for each muscle.

Whole body relaxation:

The child has to be relaxed and mentally prepared the exercise sessions. It helps for the effective training. Relaxation was given by vibratory techniques in mate and swizz ball. The child was comfortable placed in the mate (or) swizz ball, slow rhythmic, vibration was given over the trunk. Relaxation is given about for 5 minutes.

Neuro developmental therapy:

NDT was give to facilitate the child to bring out the normal neural pattern. Technique given to activates the muscle to work in the correct pattern. The training is given in the functional oriented task like reaching, sit to stand and walking. Each training was performed for 15 – 20 repetitions.

Swiss ball exercises


The traditional method given for the children with poor core muscle strength and balancing. The procedure is done to abdominal muscle facilitation, pelvic stabilization, static balance. The technique was given for 10- 15 minutes.

Weight bearing exercise:

To improve the proprioreception and sensory feed backs weight bearing exercises like standing and reaching for the object in standing was given. The child is made to stand in even surface and uneven surface and trained in functional tasking for 10 – 15 minutes.

Balance training:

The CP children usually presents with poor balancing reactions. To improve the dynamic balance training over the wobble board is given. This can improve the vestibular aspect of balancing also. Each task was performed for 10- 15 minutes.

Gait training:

To improve the normal walking pattern, gait training is given. The child is made to walk slowly to improve the weight bearing in standing foot and improve the step length and stride length. The child was made to walk over a stride lines, with in the parallel line, backward and side wards.

Static cycling:

As a warm up and cool down phase static cycling is given for 10-13 minutes. The static cycling can improve the alternative stepping.

ANNEXURE-IX
DATA OBSERVATION
TABLE –X
GMFM SCORE FOR GROUP A (EXPERIMENTAL)

S.NO	PRE	POST	D	$d-\bar{d}$	$(d-\bar{d})^2$
1	49	68	-19	0	0
2	90	110	-20	-1	1
3	62	80	-18	1	1
4	70	88	-18	1	1
5	85	99	-14	5	25
6	65	89	-24	-5	25
7	72	95	-23	-4	16
8	51	78	-27	-8	64
9	86	103	-17	2	4
10	80	100	-20	-1	1
11	45	66	-21	-2	4
12	56	66	-10	9	81
13	54	72	-18	1	1
14	82	100	-18	1	1
15	91	109	-18	1	1

Mean of pre test =69.2 ; Mean of post test = 88.2; Mean difference = -19

TABLE –XI

GMFM SCORE FOR GROUP B (CONTROL)

S.NO	**PRE**	**POST**	**D**	**$d-\bar{d}$**	**$(d-\bar{d})^2$**
1	49	58	-9	0.13	0.0169
2	70	81	-11	-1.87	3.4969
3	48	54	-11	-1.87	3.4969
4	75	84	-9	0.13	0.0169
5	55	60	-5	4.13	17.0969
6	22	95	-13	-3.87	14.9769
7	52	60	-9	0.13	0.0169
8	81	91	-9	0.13	0.0169
9	57	65	-8	1.13	1.2769
10	83	95	-12	-2.87	8.2369
11	68	75	-7	2.13	4.5369
12	98	106	-8	1.13	1.2769
13	69	75	-6	3.13	9.7969
14	84	95	-11	-1.87	3.4969
15	90	99	-9	0.13	0.0169

Mean of pre test =70.4; Mean of post test =79.67; Mean difference = -9.13

TABLE XII

MOBILITY QUESTIONNAIRE SCORE FOR GROUP A (EXPERIMENTAL)

S.NO	PRE	POST	d	$d-\bar{d}$	$(d-\bar{d})^2$
1	61	40	21	2.17	4.7089
2	75	58	17	-1.87	3.4969
3	108	85	23	4.13	17.0569
4	122	110	12	-6.87	47.1969
5	70	48	23	4.13	17.0569
6	98	75	23	4.13	17.0569
7	87	69	18	-0.87	0.7569
8	66	59	10	-8.87	78.6769
9	79	60	19	0.13	0.0169
10	80	62	18	-0.87	0.7569
11	88	60	28	9.13	83.3569
12	92	75	17	-1.87	3.4969
13	76	58	18	-0.87	0.7569
14	62	45	17	-1.87	3.4969
15	88	69	19	0.13	0.0169

Mean of pre test =82.93; Mean of post test =64.67; Mean difference = 18.87

Table XIII

MOBILITY QUESTIONNAIRE SCORE FOR GROUP B (CONTROL)

S.NO	PRE	POST	D	$d-\bar{d}$	$(d-\bar{d})^2$
1	102	89	13	2.13	4.5369
2	70	66	4	-6.87	47.1969
3	88	80	8	-2.87	8.2369
4	125	110	15	4.13	17.0569
5	64	50	14	3.13	9.7969
6	80	72	8	-2.87	8.2369
7	63	50	13	2.13	4.5369
8	71	58	13	2.13	4.5369
9	92	80	12	1.13	1.2769
10	83	70	13	2.13	4.5369
11	65	55	10	-0.87	0.7569
12	81	70	11	0.13	0.0169
13	90	81	11	0.13	0.0169
14	75	69	6	-4.87	23.7169
15	92	80	12	1.13	1.2769

Mean of pre test = 82.73; Mean of post test =72; Mean difference =10.867

TABLE XIV

6RM MUSCLE STRENGTH TEST SCORE FOE GROUP A (EXPERIMENTAL)

S.NO	PRE	POST	D	$d-d^-$	$(d-d^-)^2$
1	90	110	-20	1.4	1.96
2	100	130	-20	1.4	1.96
3	90	110	-20	1.4	1.96
4	94	110	-16	5.4	29.16
5	100	130	-20	1.4	1.96
6	90	110	-20	1.4	1.96
7	95	110	-15	6.4	40.96
8	80	100	-20	1.4	1.96
9	95	110	-15	6.4	40.96
10	105	130	-25	-3.6	12.96
11	70	90	-20	1.4	1.96
12	85	100	-15	6.4	40.96
13	90	110	-20	1.4	1.96
14	90	110	-20	1.4	1.96
15	100	130	-20	1.4	1.96

Mean of pre test = 91.6; Mean of post test = 112.67; Mean difference = -21.4

TABLE XV

6RM MUSCLE STRENGTH TEST SCORE FOE GROUP B (CONTROL)

S.NO	PRE	POST	D	$d-d^-$	$(d-d^-)^2$
1	90	95	-5	1.87	3.4969
2	100	102	-2	4.87	23.7169
3	80	80	0	6.87	47.1969
4	94	99	-5	1.87	3.4969
5	96	99	-3	3.87	14.9769
6	100	110	-10	-3.13	9.7969
7	85	90	-5	1.87	3.4969
8	97	110	-3	3.87	14.9769
9	70	80	-10	-3.13	9.7969
10	95	100	-5	1.87	3.4969
11	80	90	-10	-3.13	9.7969
12	100	110	-10	-3.13	9.7969
13	85	90	-5	1.87	3.4969
14	90	110	-20	-13.13	172.3969
15	95	105	-10	-3.13	9.7969

Mean of pre test = 90.46;Mean of post test = 98; Mean difference = -6.87

TABLE XVI
MODIFIED ASHWORTH SCALE FOR GROUP A (EXPERIMENTAL)

S.NO	PRE	POST	D	$d-\bar{d}$	$(d-\bar{d})^2$
1	3	3	0	-0.133	0.0177
2	3	3	0	-0.133	0.0177
3	3	3	0	-0.133	0.0177
4	3	3	0	-0.133	0.0177
5	2	2	0	-0.133	0.0177
6	2	2	0	-0.133	0.0177
7	3	3	0	-0.133	0.0177
8	2	1	1	0.867	0.7519
9	3	2	1	0.867	0.7519
10	2	2	0	-0.133	0.0177
11	3	3	0	-0.133	0.0177
12	2	2	0	-0.133	0.0177
13	3	3	0	-0.133	0.0177
14	3	3	0	-0.133	0.0177
15	2	2	0	-0.133	0.0177

Mean for pre test = 2.6; Mean for post test = 2.46; Mean difference = 0.133

TABLE XVII
MODIFIED ASHWORTH SCALE FOR GROUP B (CONTROL)

S.NO	PRE	POST	D	$d-\bar{d}$	$(d-\bar{d})^2$
1	2	2	0	-0.06	0.0036
2	2	2	0	-0.06	0.0036
3	2	2	0	-0.06	0.0036
4	2	2	0	-0.06	0.0036
5	2	2	0	-0.06	0.0036
6	3	3	0	-0.06	0.0036
7	3	3	0	-0.06	0.0036
8	3	3	0	-0.06	0.0036
9	2	2	0	-0.06	0.0036
10	2	2	0	-0.06	0.0036
11	3	2	1	0.96	0.8836
12	2	2	0	-0.06	0.0036
13	3	3	0	-0.06	0.0036
14	2	2	0	-0.06	0.0036
15	3	3	0	-0.06	0.0036

Mean for pre test = 2.4; Mean for post test = 2.33; Mean difference = 0.06